IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application No.	:	09/493,903
Applicants	:	Jay McCormack, et al.
Filed	:	28 January 2000
Titled	:	PARAMETRIC SHAPE GRAMMAR INTERPRETER
Art Unit	:	2671
Examiner	:	Enrique L. Santiago
Atty Docket No.	:	DB001053-000

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BRIEF OF APPLICANTS PURSUANT TO 37 C.F.R. § 1.192

Sir:

Applicants hereby submit their Brief pursuant to 37 C.F.R. § 1.192, in triplicate, concerning the above-referenced application.

(1) REAL PARTY IN INTEREST

The assignee of all right, title and interest to the above-referenced application is Carnegie Mellon University, a non-profit Pennsylvania organization.

(2) RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences involving the present application.

(3) STATUS OF CLAIMS

Claims 1-9, 12, 14-20, 24-25, and 27-41 are pending in the application. Among them, claims 20, 25, and 27-29 are allowed and claims 9, 17-18, 31, 37, and 40 have been objected to, but found allowable if rewritten in independent form. The remaining claims 1-8, 12, 14-16, 19, 24, 30, 32-36, 38-39, and 41 stand rejected as being obvious under 35 U.S.C. § 103(a) in view of Balz et al. (U.S. Patent No. 5,929,865) ("Balz"), Usami et al. (U.S. Patent No. 5,379,371) ("Usami"), and Trew et al. (U.S. Patent No. 5,280,530) ("Trew") in the Office Action of November 25, 2003 ("the final action") and also in the Advisory Action dated April 14, 2004.

(4) STATUS OF AMENDMENTS

Applicants filed a response under 37 C.F.R. § 1.116 to the final action amending claims 1, 7-9, 12, 24, and 30. That response has been entered by the Examiner for the purpose of this Appeal.

(5) SUMMARY OF INVENTION

The claimed invention relates to shape grammar systems and methods having parametric shape recognition. A shape grammar is a set of rules, based on shape, that is used to generate designs through rule applications. Rules take the form of $a \rightarrow b$, where a and b both denote shapes. A rule is applicable if the left-hand shape, a, can be found in the design shape, denoted c. (Page 1, lines 15-21.) If the rule is applied, the left hand shape is subtracted from the design and the right-hand shape is added to the design, denoted $c\text{-}\tau(a)+\tau(b)$, where shapes a and b undergo a transformation τ to make shape a a subshape of shape c. (Page 2, lines 1-3.)

The shape grammar system 10 (Figure 1) includes a parametric shape grammar interpreter 12, including a shape decomposition module 14 and a shape recognition module 16. The shape grammar system 10 also includes a rule application module 18 and an intelligent rule selection module 20, which are in communication with the parametric shape grammar interpreter 12. The parametric shape grammar interpreter 12 may be used to recognize the left-hand shape of a shape grammar rule in the initial design shape(s) through the steps of decomposing the shape into subshapes and progressively searching for parametric transformations of those subshapes. (Page 4, line 21 – page 5, line 12.)

The parametric shape grammar interpreter 12 may also perform the operations necessary to determine whether any of a predefined set of shape grammar rules may be applied to a

particular shape (or set of shapes). Once the interpreter 12 determines whether a rule may be applied and how to apply the rule, whether the rule should be applied to the shape may be determined, for example, by a user of the system 10 or the intelligent rule selection module 20. The rule application module 18 may then apply the rule to the shape if so determined. The shape decomposition module 14 decomposes a shape such as, for example, the left-hand shape of a rule (the shape a in the rule $a \rightarrow b$) into a group of subshapes contained in the shape. The groups may be defined such that subshapes belonging to different groups do not share, for example, line segments for two-dimensional shapes. The group of shapes may be ordered according to a hierarchy of, for example, decreasing restrictions or constraints for more efficient searching. (Page 5, line 3 – page 6, line 1.)

Figures 12-19 provide an example of parametric shape recognition, using the example default hierarchy defined in Table 1 (page 8), to recognize the presence of parametric transformations of the left-hand shape (a) of the rule ($a \rightarrow b$) in a design shape (C_0). The rule is illustrated in Figure 12 and the initial design shape (C_0) to which the rule is to be applied is shown in Figure 13. For the shape a, using the default hierarchy in Table 1, the subshapes comprising groups s_1 and s_2 are shown in Figure 14. (Page 18, lines 7-22.)

Permissible transformations of the s_1 subshape may be found multiple times in the shape a, resulting in four instances of s_1 subshapes in this example. These transformations are defined as set S_1 and are shown in Figure 15. The dots in Figure 15 are to show the various transformations of the s_1 subshape found in the shape a. Having found the set of shapes S_1, the set of shapes C_1 (shown in Figure 16) is generated, which is the result of the set of shapes S_1 subtracted from C_0. The relative connectivity of the shapes of groups s_1 and s_2, as well as the relative connectivity of the transformed instance of s_1 and the set of C_1 shapes may be identified, as illustrated in Figure 17. (Page 19, lines 1-13.)

Next, the set of shapes C_1 is searched for the next most constrained subshape group, which for this example, is the s_2 group (Figure 14). Two permissible transformations of the s_2 subshape may be found in each of the shapes of C_1. The set of the subshapes thus define the set S_2. Next, the set of shapes S_2 is subtracted from the set of shapes C_1 to define the set of shapes C_2 (not shown). The intersection points between the marked shapes S_2 and the corresponding shapes C_2 are also identified (not shown).

The sets S_1 and S_2 are then added such that their connectivity is maintained to produce the subshapes illustrated in Figure 18. These subshapes in Figure 18 represent the parametric transformations of the left-hand shape *a* of the rule $a \rightarrow b$ (illustrated in Figure 12) found in the initial design shape C_0 (illustrated in Figure 13). The two possible applications of the rule may then be applied to the shape C_0 to produce the shapes illustrated in Figure 19. (Page 19, line 20 – page 20, line 3.)

Other figures in the specification provide additional examples of the application of parametric shape grammar rules using the methodology described in the specification.

(6) CONCISE STATEMENT OF ISSUES PRESENTED FOR REVIEW

The questions presented in this appeal are:

(A) Do the Usami and Trew references provide the teachings asserted by the Office; and (B) Is there some motivation found in the art for combining the teachings of the references as asserted by the Office?

(7) GROUPING OF CLAIMS

Applicants submit that, for the purpose of this appeal only, all of the independent claims (1, 12, 24, 30, 32, 34, 36 an 39) stand or fall together. Furthermore, the dependent claims are grouped as follows: Claims 2-8 and 14-16 constituting Group-I, claim 19 constituting Group-II, and claims 33, 35, 38, and 41 constituting Group-III.

The claims on appeal are reproduced in the attached Appendix.

(8) ARGUMENT

(A) <u>The References Do Not Provide the Teachings As Asserted by the Office.</u>

Balz teaches a method for sorting two-dimensional graphics data into raster lines by decomposing the graphic images into vector line and arc segments with their associated two-dimensional coordinates (Figs. 1-2). A vector or sub-shape list is then established containing the coordinates of all the vector lines and arcs. Sorting is then performed on the vector data by organizing each vector based upon its X- or Y- coordinate information. Pixels that make up each sub-shape are then computed. This computation is performed for each sub-shape in the order given by the sorted, sub-shape list. The resultant pixel list is ordered according to the X- or Y-dimensional sort previously performed. Pixels generated in a partially pre-sorted arrangement

are arranged in a pixel array. The stored pixel array is then used to form raster lines. (Balz, Abstract)

By the Examiner's own admission, Balz "does not directly teach an apparatus for arranging sub-shapes in a hierarchical order" (the final action, page 2) or an "apparatus for recognizing transformations of a first shape in a second shape" (the final action, page 3). The Examiner relies upon Usami for teaching the first proposition and Trew for teaching the second. In both instances, the Examiner reads too much into the references.

Usami teaches a display apparatus and a modeling method for computer graphics including a first memory for storing a first three-dimensional model—a detailed model—of a body represented by at least one of: a desired first number of dimensions, a desired first number of parameters, and desired first parametric quantities. Usami further teaches an arithmetic unit for arithmetically determining a second three-dimensional model—a simplified model—by varying at least one of: the first number of dimensions, the first number of parameters, and the first parametric quantities to at least one of: a second number of dimensions, a second number of parameters, and second parametric quantities in accordance with an algorithm, thereby automatically creating a simplified model for a body of less importance. A second memory stores the simplified model. A display unit displays the first three-dimensional model or the second three-dimensional model as selected. (Usami, Abstract) Thus, Usami teaches to discriminatively identify a body of less importance in a scene and decrease the number of parameters or dimensions of a detailed model of that body to thereby create a simplified model for the display in an automatic manner, thereby speeding-up the processing for display. (Usami, column 17, lines 42-48.) Figs. 3-6 in Usami are illustrative.

The Examiner points to figures 4 and 12 in Usami as well as column 2, lines 58-59, column 5, lines 19-30 and column 15, lines 21-23 for the proposition that Usami teaches arranging subshapes in a hierarchical order. However, a close review of Usami leads one to conclude that Usami does not teach arranging subshapes in hierarchical order.

Looking at, for example, figure 4 in Usami, the "body level" indicates that body 1 and body 2 comprise the scene. Thus, body 1 and body 2 may be broadly viewed as "subshapes" which comprise the scene. However, body 1 and body 2 are not hierarchically arranged as required by the claims. Similarly, at the "part level", body 1 is comprised of part 1 and part 2, etc. Again it is seen that the parts are not hierarchically arranged. It is thus seen in figure 4 that

each horizontal row comprises the scene, but there is no hierarchical arrangement within each of the rows.

In contrast, in independent claims 1, 12, 24, 30, 34 and 39, the subshapes (or subshape groups) are hierarchically arranged. For the subshapes of Usami to be hierarchically arranged, such arrangement would need to occur within the horizontal rows of figure 4. For example, at the "figure element level", the spheres, cylinders and planes comprising part 1 would need to be hierarchically arranged. Clearly they are not. The portions of Usami identified by the Examiner do not teach hierarchically arranged subshapes.

As to independent claims 32 and 36, those claims require that the searching be performed in a hierarchical manner even though the subshapes themselves may not be hierarchically arranged. In either case, contrary to the assertions by the Examiner, Applicants fail to find any teaching of such hierarchical searching in Usami. For that reason alone, the independent claims should be allowed.

Regarding the reference to Trew (as applied to each of the rejected independent claims 1, 12, 24, 30, 32, 34, 36, and 39), that reference does not teach searching a second shape for the subshapes or a transformation of the subshapes. Trew does not search for shapes at all. Rather, Trew uses templates (see figures 2 through 5) to find matches based on patterns of pixel intensity. That may be referred to as content based searching as the search is based on the content (pixel intensities) within the search area. The independent claims contain a reference to searching a second shape for the subshapes or for a transformation of the subshapes to clearly define over content based types of searches. For that reason alone, the independent claims should be allowed.

B. The Combination of References is Improper

Applicants respectfully submit that the Examiner has pieced together three references to facilitate the Examiner's position that the "combination" of references renders the pending claims obvious. However, MPEP § 2143.01 instructs that "[t]he mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. In re Mills, 916 F.2d 680, 16 USPQ 2d 1430 (Fed. Cir. 1990)." (Emphasis in original.) MPEP § 2143.01 further instructs that "[a]lthough a prior art device 'may be capable of being modified to run the way the apparatus is claimed, there must be a suggestion or motivation in the reference to do so.'" In re Mills, 916 F. 2d at 682.

Furthermore, per MPEP § 2143, "the teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in applicant's disclosure. In re Vaeck, 947 F. 2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991)."

In combining the teachings of Balz and Usami, the Examiner's rationale appears to be that such combination "would make it possible to define a geometrical configuration or shape of a three-dimensional model in terms of a set of graphic elements in the computer based on the input information of a detailed model. Additionally the information of the visual field could be used for determining the position of the point of view in three-dimensional space, which, may then be given in terms of the coordinate values of an orthogonal (X-Y-Z) coordinate system." (final action, page 3, citing Usami, column 5, lines 30-39.)

The above quoted description from Usami is merely an application of Usami's teachings and does not provide any suggestion or motivation to combine the teachings of Usami with the teachings of Balz. Thus, Applicants fail to find any teachings, suggestion, or motivation, either in Balz or in Usami, for the desirability to combine the three-dimensional modeling method of Usami with the image to raster line conversion of Balz. Applicants assert that just because the teachings of Balz and Usami broadly relate to computer-based graphics implementations, that observation, in and of itself, is an insufficient reason or motivation to combine Balz and Usami absent any express teaching or suggestion in the prior art of the desirability of such a combination.

Furthermore, in combining Balz and Usami with Trew, the Examiner appears to suggest that Trew is combinable with Balz and Usami because "it would be used to identify a face (or other objects) in a picture, and for tracking a face (or other objects) in successive frames." (final action, page 3, citing Trew, column 5, lines 41-56.) As before, the reproduction in the final action of the above statements from Trew merely indicate the utility of Trew's invention. Applicants again assert that they fail to find any teaching, suggestion, or motivation in the art to combine Trew's teachings with those in Balz and Usami. The discussion in Trew of tracking of a three-dimensional object in a scene over a series of two dimensional picture frames is, in and of itself, insufficient reason or motivation to combine the teachings of Trew with quite unrelated teachings of Balz or Usami. Because the prior art fails to teach or suggest the desirability of modeling of a three-dimensional image (as, for example, is done in Usami) or the desirability of sorting of two-dimensional graphics (e.g., the two dimensional picture frames in Trew) using

pixel-based decomposition or sorting (as, for example, is taught in Balz), Applicants assert that the combination of Trew with Balz and Usami is improper.

(C) The Dependent Claims Are Patentable

The dependent claims recite further specific limitations that have no reasonable correspondence with the references. It is submitted that, with reference to the dependent claims in Group-I, there is no teaching in the references of "decomposing a left-hand shape of a shape grammar rule" as required by dependent claims 2 (and also by claims 3-8 by virtue of their dependence on claim 2) and 14 (and also by claims 15-16 by virtue of their dependence on claim 14). Regarding claims 2 and 14, the Examiner cites figures 1 and 2, column 2, line 59 – column 3, line 8, and column 3, lines 39-53 in Balz as teaching "a shape decomposition module for decomposing a left-hand shape into at least one sub-shape belong to one of a plurality of subshapes." (The final action, page 3.) However, Applicants fail to find support for any such teaching in the cited portions in Balz.

It is further submitted that the references fail to teach, either alone or in combination, the step of "applying a rule" as required by dependent claims in Group-III (i.e., claims 33, 35, 38, and 41). In rejecting claims 33 and 35, on page 6 in the final action, the Examiner referred to figure 1, column 2, lines 46-58, and column 3, lines 40-53 in Balz as teaching "an intelligent rule selection module in communication with the parametric shape interpreter." It is observed here that no such limitations are present in claims 33 and 35. On the same page in the final action, the Examiner rejected claims 38 and 41 by reference to column 2, lines 20-42, column 3, line 64, column 4, line 2, and column 15, lines 3-5 in Trew as teaching the application of "a rule when all of a plurality of sub-shapes from a first shape are identified in a series of second shapes." Therefore, the Applicants have assumed that the Examiner's position as to claims 38 and 41 applies to claims 33 and 35 as well because of the presence of the "applying a rule" limitation in all claims in Group-III. Assuming application of Trew to claims 33 and 35, Applicants still fail to find support for any teaching of "applying a rule" in the cited portions of Trew. Further, contrary to the Examiner's position, the cited portions of Balz are also devoid of any teaching of "applying a rule".

In rejecting the dependent claim 19 in Group-II, the Examiner referred to figure 1, column 3, lines 40-53 in Balz as teaching "an intelligent rule selection module in communication

with the parametric shape interpreter." (The final action, page 4.) However, Applicants again fail to find in the cited portion in Balz any teaching of "an intelligent rule selection module" as recited in claim 19.

Applicants emphasize that the terms quoted herein from various dependent claims, when interpreted consistent with the specification in the present application as required by MPEP and the caselaw, render all of the dependent claims on appeal (i.e., claims 2-8, 14-16, 19, 33, 38, and 41) non-obvious over the combination of the cited references.

CONCLUSION

For the reasons advanced above, Applicants respectfully urge that the rejection of claims 1-8, 12, 14-16, 19, 24, 30, 32-36, 38-39, and 41 as being obvious under 35 U.S.C. § 103(a) is improper and should be reversed.

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(a) APPENDIX

Listing of Claims on Appeal

1. A parametric shape interpreter, comprising:

a shape decomposition module for decomposing a first shape into a group of subshapes arranged in a hierarchical order; and

a shape recognition module in communication with the shape decomposition module for searching a second shape for said subshapes .

2. The parametric shape interpreter of claim 1, wherein the shape decomposition module is for decomposing a left-hand shape of a shape grammar rule into at least one subshape belonging to one of a plurality of subshape groups.

3. The parametric shape interpreter of claim 2, wherein the subshape groups have a hierarchical order of decreasing constraints.

4. The parametric shape interpreter of claim 2, wherein the shape decomposition module is for decomposing a two-dimensional left-hand shape of a shape grammar rule into one or more subshapes.

5. The parametric shape interpreter of claim 2, wherein the shape decomposition module is for decomposing a three-dimensional left-hand shape of a shape grammar rule into one or more subshapes.

6. The parametric shape interpreter of claim 2, wherein the shape decomposition module is for decomposing a one-dimensional left-hand shape of a shape grammar rule into one or more subshapes.

7. The parametric shape interpreter of claim 2, wherein the shape recognition module is for searching said second shape for a parametric transformation of the subshape.

8. The parametric shape interpreter of claim 2, wherein the shape recognition module is for recognizing a parametric transformation of the left-hand shape of the shape grammar rule in said second shape by searching said second shape for a parametric transformation of the subshape.

12. A shape grammar system, comprising:

a parametric shape grammar interpreter for recognizing parametric transformations of a first shape in a second shape, said interpreter comprising a shape decomposition module for decomposing said first shape into a group of subshapes arranged in a hierarchical order and

a shape recognition module in communication with the shape decomposition module for searching said second shape for said subshapes; and

a rule application module in communication with the parametric shape grammar interpreter.

14. The shape grammar system of claim 12, wherein the shape decomposition module is for decomposing a left-hand shape of a shape grammar rule into at least one subshape belonging to one of a plurality of subshape groups.

15. The shape grammar system of claim 14, wherein the subshape groups have a hierarchical order of decreasing constraints.

16. The shape grammar system of claim 14, wherein the shape recognition module is for recognizing a parametric transformation of the left-hand shape of the shape grammar rule in said second shape by searching said second shape for a parametric transformation of the subshape.

19. The shape grammar system of claim 12, further comprising an intelligent rule selection module in communication with the parametric shape grammar interpreter.

24. A parametric shape interpreter, comprising:

means for decomposing a first shape into at least one subshape belonging to one of a plurality of subshape groups arranged in a hierarchical order; and

means for recognizing a parametric transformation of the first shape in a second shape by searching the second shape for a parametric transformation of the subshapes comprising said first shape.

30. A method of recognizing a first shape in a second shape, comprising:

decomposing the first shape into at least one subshape belonging to one of a plurality of hierarchically arranged subshape groups; and

searching the second shape for a parametric transformation of the subshapes comprising said first shape.

32. A method, comprising:

decomposing a first shape into a plurality of subshapes;

searching in a hierarchical manner in a second shape for said plurality of subshapes; and

identifying instances of said subshapes in said second shape based on said searching.

33. The method of claim 32 additionally comprising applying a rule when said first shape is identified in said second shape.

34. A method, comprising:

decomposing a first shape into a plurality of hierarchically ordered subshapes;

searching in a second shape for said plurality of subshapes; and

identifying instances of said subshapes in said second shape based on said searching.

35. The method of claim 34 additionally comprising applying a rule when said first shape is identified in said second shape.

36. An automated method, comprising:

decomposing a first shape into a plurality of subshapes;

searching in a hierarchical manner in a series of second shapes for said plurality of subshapes; and

identifying instances of said subshapes in said series of second shapes based on said searching.

38. The method of claim 36 additionally comprising applying a rule when all of said plurality of subshapes from said first shape are identified in said series of second shapes.

39. An automated method, comprising:

decomposing a first shape into a plurality of hierarchically ordered subshapes;

searching in a series of second shapes for said plurality of subshapes; and

identifying instances of said subshapes in said series of second shapes based on said searching.

41. The method of claim 39 additionally comprising applying a rule when all of said plurality of subshapes from said first shape are identified in said series of second shapes.